

FORM PTO-1390 (Modified)
(REV 11-2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

0203-0011

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

To Be Determined 10/031336

INTERNATIONAL APPLICATION NO.

PCT/GB00/02781

INTERNATIONAL FILING DATE

19-July-2000

PRIORITY DATE CLAIMED

19-July-1999

TITLE OF INVENTION

Improvements Relating to Screen Printing

APPLICANT(S) FOR DO/EO/US

LAMBERT, Philip John

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☐ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☐ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

1) International Application as published, Publication No. WO01/05592; 2) Form PCT/IPEA/416; 3) PCT Request; 4) Form PCT/RO/105; 5) Form PCT/IB/301; 6) Form PCT/IB/304; 7) Form PCT/IB/308; and 8) postcard.

U.S. APPLICATION NO. (IF KNOWN) SEE 37 CFR 1.53(b) To Be Determined		INTERNATIONAL APPLICATION NO. PCT/GB00/02781		ATTORNEY'S DOCKET NUMBER 0203-0011	
24. The following fees are submitted:				CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :					
<input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1040.00					
<input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$890.00					
<input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$740.00					
<input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$710.00					
<input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00					
ENTER APPROPRIATE BASIC FEE AMOUNT =				\$890.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than _____ months from the earliest claimed priority date (37 CFR 1.492 (e)). <input type="checkbox"/> 20 <input type="checkbox"/> 30				\$0.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	13 - 20 =	0	x \$18.00	\$0.00	
Independent claims	2 - 3 =	0	x \$84.00	\$0.00	
Multiple Dependent Claims (check if applicable). <input type="checkbox"/>				\$0.00	
TOTAL OF ABOVE CALCULATIONS =				\$890.00	
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$0.00	
SUBTOTAL =				\$890.00	
Processing fee of \$130.00 for furnishing the English translation later than _____ months from the earliest claimed priority date (37 CFR 1.492 (f)). <input type="checkbox"/> 20 <input type="checkbox"/> 30				\$0.00	
TOTAL NATIONAL FEE =				\$890.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). <input type="checkbox"/>				\$0.00	
TOTAL FEES ENCLOSED =				\$890.00	
				Amount to be: refunded	\$
				charged	\$

- a. ☒ A check in the amount of **\$890.00** to cover the above fees is enclosed.
- b. ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.
- c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **50-0622**. A duplicate copy of this sheet is enclosed.
- d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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Mark R. Shanks
 SIGNATURE

Mark R. Shanks

NAME

33,781

REGISTRATION NUMBER

1/18/02
 DATE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: LAMBERT

Art Unit: To Be Determined

Serial No.: To Be Determined

Examiner: To Be Determined

Filed: Herewith

Atty. Docket: 0203-0011

For: Improvements Relating to Screen Printing

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination of the above-identified application, Applicant herewith respectfully requests the following amendments:

IN THE SPECIFICATION:

On page 2, paragraph 4, line 1, --WO-A-90/20088-- should be amended to --WO-A-96/20088 as shown on the attached marked-up and clean copies of page 2.

On page 6, please delete paragraphs 1 and 2 as shown on the attached marked-up copy of page 6.

IN THE CLAIMS:

Claims 3-4 and 7-11 have been amended to correct multiple dependency, and claims 14 and 15 have been deleted as shown on the attached marked-up and clean copies.

REMARKS

It is respectfully requested that the Examiner enter these amendments prior to examining the application on its merits.

Respectfully submitted,

SHANKS & HERBERT

By: Mark R Shanks
Mark R. Shanks
Reg. No. 33,781

Date: 1/18/02

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conjunction with the adhesion of the pasty product 2 to the stencil 3 causes the pasty product 2 to roll across the stencil 3 as depicted by arrows 6, thereby shear thinning the pasty product 2.

There are many problems associated with this screen printing technique. One problem is that exposure of the pasty product 2 to the atmosphere results in evaporation of the solvents of the pasty product 2 and hence drying of the pasty product 2. Another problem is that increasing the speed of the squeegee 1 to increase the downward force F_2 which forces the pasty product 2 into the apertures 4 of the stencil 3, not only reduces the time available to fill the apertures 4, but can also cause the pasty product 2 to slide across the stencil 3, thereby reducing the rolling effect and hence the shear thinning.

Screen printing heads have been proposed, for example as disclosed in US-A-4622239, which enclose the pasty product to overcome the problems of evaporation, but these printing heads have not addressed the problem of setting a suitable print speed.

WO-A-⁹⁶~~90~~/20088 discloses a screen printing head which attempts to overcome both the problems of evaporation and the setting of the print speed by applying a pressure directly to the pasty product. However, this printing head does not provide for a rolling action of the pasty product and hence shear thinning of the same. Furthermore, this printing head requires a very high pressure to be applied to the pasty product. This high pressure can result in the separation of the metallic and flux components of solder pastes which results in inconsistent printing.

WO-A-98/16387 discloses a screen printing head which has been developed partially in response to the known problems of evaporation and the setting of the print speed. As illustrated in Figure 2, this printing head comprises a main body 10, first and second wiper blades 11, 12, which contact a stencil 13 and together with the main body 10 define a chamber 15 containing a pasty product 16, a grille 17 located at the lower end of the main body 10, and a piston 18 for applying a downward force F_2 on the pasty product 16. The stencil 13, which includes a plurality of apertures 19, is located above a circuit board 20

The present invention further provides a printing head for screen printing, through which printing head pasty product to be printed can be pressed by applied pressure, comprising a chamber into which pasty product can be charged and in which the same can be placed under pressure, an exit slot from the chamber for pasty product to be printed and a downstream chamber in communication with the exit slot, wherein the downstream chamber is closed at an exit end thereof in use by flexible wiper blades and by a portion of a screen through which the pasty product is to be printed, and the downstream chamber is subdivided by vanes to define pasty product flow paths along which pasty product will flow as a result of movement of the printing head over the stencil in use, the flow paths comprising circulating flow above the wiper blades and flow towards the stencil between the vanes as a result of the circulating flows and movement of the pasty product through the exit slot due to the applied pressure.

The present still further provides a method of screen printing using a printing head, through which printing head pasty product to be printed is pressed by applied pressure, comprising the steps of charging pasty product into a chamber and placing the same under pressure for movement towards an exit slot from the chamber and into a downstream chamber in communication with the exit slot, the downstream chamber being closed at an exit end thereof by flexible wiper blades and by a portion of a screen through which the pasty product is to be printed, subdividing the downstream chamber by vanes to define pasty product flow paths along which pasty product flows as a result of movement of the printing head over the stencil, the flow paths comprising circulating flow above the wiper blades and flow towards the stencil between the vanes as a result of the circulating flows and movement of the pasty product through the exit slot due to the applied pressure.

A preferred embodiment of the present invention will now be described hereinbelow by way of example only with reference to the accompanying drawings, in which:

Figure 1 illustrates a sectional view through a squeegee as employed in a traditional screen printing technique;

CLAIMS

1. A screen printing head for applying a pasty product to a printing screen, comprising:
a main body;
wiper blades disposed to the main body for contacting a printing screen;
a first chamber providing a reservoir for containing a supply of pasty product, the first chamber being defined at least in part by the main body and including at least one outlet opening through which pasty product is in use forced under pressure;
a second chamber in fluid communication with the at least one outlet opening, the second chamber being defined in part by the main body and the wiper blades and being in use in communication with the printing screen; and
a flow director disposed in the second chamber and configured such as in use to cause a circulatory flow of pasty product contained therein which passes over the surface of the printing screen and a flow of pasty product towards the printing screen which acts to force pasty product of the circulatory flow towards the printing screen and into apertures therein.
2. The printing head of claim 1, wherein the at least one outlet opening comprises an elongate slot.
3. The printing head of claim 1 ~~or 2~~, wherein the flow director is further configured such as to define first and second circulation zones in which pasty product is locally circulated and through which the circulatory flow is directed.
4. The printing head of ~~any of claims 1 to 3~~, wherein the flow director comprises vanes, with the circulatory flow in use passing beneath the lower edges of the vanes.
5. The printing head of claim 4, comprising first and second vanes disposed on opposed sides of the at least one outlet opening, with the lower edges of the vanes defining a nozzle directed towards the printing screen.
6. The printing head of claim 5, wherein the nozzle is an elongate nozzle.
7. The printing head of ~~any of claims 1 to 6~~, wherein the main body includes first and second lobe members which in part define the second chamber, the lobe members being disposed above respective ones of the wiper blades and having arcuate lower surfaces so as to promote the circulatory flow.

8. The printing head of ~~any of claims 1 to 7~~, wherein the main body includes one or more ports through which the first chamber can be charged with pasty product.
9. The printing head of ~~any of claims 1 to 7~~, wherein the main body includes a replaceable cassette which defines at least in part the first chamber, the first chamber being charged by replacement of the cassette.
10. The printing head of ~~any of claims 1 to 9~~, wherein the wiper blades comprise flexible wiper blades.
11. A screen printing apparatus comprising the printing head of ~~any of claims 1 to 10~~.
12. A method of screen printing using a screen printing head including a chamber in communication with the printing screen, comprising the steps of:
providing a circulatory flow of pasty product in the chamber which passes over the surface of the printing screen; and
providing a flow of pasty product towards the printing screen which acts to force pasty product of the circulatory flow onto the printing screen and into apertures therein.
13. The method of claim 12, further comprising the step of locally circulating pasty product in first and second circulation zones through which the circulatory flow is directed.
14. ~~(deleted). A screen printing head for screen printing, through which printing head pasty product to be printed can be pressed by applied pressure, comprising a chamber into which pasty product can be charged and in which the same can be placed under pressure, an exit slot from the chamber for pasty product to be printed and a downstream chamber in communication with the exit slot, wherein the downstream chamber is closed at an exit end thereof in use by flexible wiper blades and by a portion of a screen through which the pasty product is to be printed, and the downstream chamber is subdivided by vanes to define pasty product flow paths along which pasty product will flow as a result of movement of the printing head over the stencil in use, the flow paths comprising circulating flow above the wiper blades and flow towards the stencil between the vanes as a result of the circulating flows and movement of the pasty product through the exit slot due to the applied pressure.~~
15. ~~(deleted). A method of screen printing using a printing head, through which printing head pasty product to be printed is pressed by applied pressure, comprising the steps of charging pasty product into a chamber and placing the same under pressure for~~

~~movement towards an exit slot from the chamber and into a downstream chamber in communication with the exit slot, the downstream chamber being closed at an exit end thereof by flexible wiper blades and by a portion of a screen through which the pasty product is to be printed, subdividing the downstream chamber by vanes to define pasty product flow paths along which past product flows as a result of movement of the printing head over the stencil, the flow paths comprising circulating flow above the wiper blades and flow towards the stencil between the vanes as a result of the circulating flows and movement of the pasty product through the exit slot due to the applied pressure.~~

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conjunction with the adhesion of the pasty product 2 to the stencil 3 causes the pasty product 2 to roll across the stencil 3 as depicted by arrows 6, thereby shear thinning the pasty product 2.

There are many problems associated with this screen printing technique. One problem is that exposure of the pasty product 2 to the atmosphere results in evaporation of the solvents of the pasty product 2 and hence drying the pasty product 2. Another problem is that increasing the speed of the squeegee 1 to increase the downward force F_2 which forces the pasty product 2 into the apertures 4 of the stencil 3, not only reduces the time available to fill the apertures 4, but can also cause the pasty product 2 to slide across the stencil 3, thereby reducing the rolling effect and hence the shear thinning.

Screen printing heads have been proposed, for example as disclosed in US-A-4622239, which enclose the pasty product to overcome the problems of evaporation, but these printing heads have not addressed the problem of setting a suitable print speed.

WO-A-96/20088 discloses a screen printing head which attempts to overcome both the problems of evaporation and the setting of the print speed by applying a pressure directly to the pasty product. However, this printing head does not provide for a rolling action of the pasty product and hence shear thinning of the same. Furthermore, this printing head requires a very high pressure to be applied to the pasty product. This high pressure can result in the separation of the metallic and flux components of solder pastes which results in inconsistent printing.

WO-A-98/16387 discloses a screen printing head which has been developed partially in response to the known problems of evaporation and the setting of the print speed. As illustrated in Figure 2, this printing head comprises a main body 10, first and second wiper blades 11, 12, which contact a stencil 13 and together with the main body 10 define a chamber 15 containing a pasty product 16, a grille 17 located at the lower end of the main body 10, and a piston 18 for applying a downward force F_2 on the pasty product 16. The stencil 13, which includes a plurality of apertures 19, is located above a circuit board 20

A preferred embodiment of the present invention will now be described hereinbelow by way of example only with reference to the accompanying drawings, in which:

Figure 1 illustrates a sectional view through a squeegee as employed in a traditional screen printing technique;

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CLAIMS

1. A screen printing head for applying a pasty product to a printing screen, comprising:
a main body;
wiper blades disposed to the main body for contacting a printing screen;
a first chamber providing a reservoir for containing a supply of pasty product, the first chamber being defined at least in part by the main body and including at least one outlet opening through which pasty product is in use forced under pressure;
a second chamber in fluid communication with the at least one outlet opening, the second chamber being defined in part by the main body and the wiper blades and being in use in communication with the printing screen; and
a flow director disposed in the second chamber and configured such as in use to cause a circulatory flow of pasty product contained therein which passes over the surface of the printing screen and a flow of pasty product towards the printing screen which acts to force pasty product of the circulatory flow towards the printing screen and into apertures therein.
2. The printing head of claim 1, wherein the at least one outlet opening comprises an elongate slot.
3. The printing head of claim 1, wherein the flow director is further configured such as to define first and second circulation zones in which pasty product is locally circulated and through which the circulatory flow is directed.
4. The printing head of claim 1, wherein the flow director comprises vanes, with the circulatory flow in use passing beneath the lower edges of the vanes.
5. The printing head of claim 4, comprising first and second vanes disposed on opposed sides of the at least one outlet opening, with the lower edges of the vanes defining a nozzle directed towards the printing screen.
6. The printing head of claim 5, wherein the nozzle is an elongate nozzle.
7. The printing head of claim 1, wherein the main body includes first and second lobe members which in part define the second chamber, the lobe members being disposed above respective ones of the wiper blades and having arcuate lower surfaces so as to promote the circulatory flow.

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8. The printing head of claim 1, wherein the main body includes one or more ports through which the first chamber can be charged with pasty product.
9. The printing head of claim 1, wherein the main body includes a replaceable cassette which defines at least in part the first chamber, the first chamber being charged by replacement of the cassette.
10. The printing head of claim 1, wherein the wiper blades comprise flexible wiper blades.
11. A screen printing apparatus comprising the printing head of claim 1.
12. A method of screen printing using a screen printing head including a chamber in communication with the printing screen, comprising the steps of:
providing a circulatory flow of pasty product in the chamber which passes over the surface of the printing screen; and
providing a flow of pasty product towards the printing screen which acts to force pasty product of the circulatory flow onto the printing screen and into apertures therein.
13. The method of claim 12, further comprising the step of locally circulating pasty product in first and second circulation zones through which the circulatory flow is directed.
14. (deleted).
15. (deleted).

IMPROVEMENTS RELATING TO SCREEN PRINTING

The present invention relates to screen printing and particularly to screen printing in which pasty product to be printed is contained within a screen printing head and delivered through the printing head by applied pressure.

It is an established technique in the assembly of printed circuit boards to deposit solder paste where connections are to be made with components, place the components on the paste deposits, and then heat the assembly to re-flow the paste and complete the connections. Screen printing machines have been used to deposit solder paste onto printed circuit boards through the apertures of a stencil or screen.

Solder paste consists of metallic microspheres of solder joined by an organic material or flux. The metallic content of such solder paste typically makes up 50 % of the volume, and up to 90 % of the weight of the paste. The viscous flux consists of rheologic agents, adhesive agents and cleaning agents, some of which are thixotropic and others of which are volatile solvents. The thixotropic property of the solder paste has the effect that relative movement of regions within the paste causes a process of shear thinning to locally reduce the viscosity of the paste.

A typical print will comprise a multiplicity of small blocks of solder paste, and for consistent quality it is essential that each block contains the same proportions of each constituent material. This requires a consistent homogeneous distribution of the materials within the solder paste.

In one traditional screen printing technique, as illustrated in Figure 1, an inclined squeegee 1 is used to push a volume of a pasty product 2 over a stencil 3 which includes apertures 4 and is located above a circuit board 5, thereby filling the apertures 4 in the stencil 3 and providing a deposit on the circuit board 5. Forward movement of the squeegee 1, with a horizontal force F1, causes a downward force F2 to be applied to the pasty product 2. This downward force F2 forces the pasty product 2 into the apertures 4 in the stencil 3, and in

conjunction with the adhesion of the pasty product 2 to the stencil 3 causes the pasty product 2 to roll across the stencil 3 as depicted by arrows 6, thereby shear thinning the pasty product 2.

There are many problems associated with this screen printing technique. One problem is that exposure of the pasty product 2 to the atmosphere results in evaporation of the solvents of the pasty product 2 and hence drying of the pasty product 2. Another problem is that increasing the speed of the squeegee 1 to increase the downward force F_2 which forces the pasty product 2 into the apertures 4 of the stencil 3, not only reduces the time available to fill the apertures 4, but can also cause the pasty product 2 to slide across the stencil 3, thereby reducing the rolling effect and hence the shear thinning.

Screen printing heads have been proposed, for example as disclosed in US-A-4622239, which enclose the pasty product to overcome the problems of evaporation, but these printing heads have not addressed the problem of setting a suitable print speed.

WO-A-90/20088 discloses a screen printing head which attempts to overcome both the problems of evaporation and the setting of the print speed by applying a pressure directly to the pasty product. However, this printing head does not provide for a rolling action of the pasty product and hence shear thinning of the same. Furthermore, this printing head requires a very high pressure to be applied to the pasty product. This high pressure can result in the separation of the metallic and flux components of solder pastes which results in inconsistent printing.

WO-A-98/16387 discloses a screen printing head which has been developed partially in response to the known problems of evaporation and the setting of the print speed. As illustrated in Figure 2, this printing head comprises a main body 10, first and second wiper blades 11, 12, which contact a stencil 13 and together with the main body 10 define a chamber 15 containing a pasty product 16, a grille 17 located at the lower end of the main body 10, and a piston 18 for applying a downward force F_2 on the pasty product 16. The stencil 13, which includes a plurality of apertures 19, is located above a circuit board 20

onto which deposits of the pasty product 16 are to be printed. In use, the printing head is moved in one of two opposite printing directions, with a horizontal force F_1 , which causes the wiper blades 11, 12, which are pressed against the stencil 13 by the force imparted on the pasty product 16 by the piston 18, to act to lift the pasty product 16 from the region above the stencil 13 and cause the pasty product 16 to pass upwardly through the grille 17, which pasty product 16 is subsequently forced back downwardly through the grille 17 by the action of the pressure developed by the piston 18. This rolling action of the pasty product 16, as depicted by arrows 21, shear thins the pasty product 16 and thereby enables the pressure F_2 applied by the piston 18 to be maintained at a low level and also prevents separation of the components of the pasty product 16 by the mixing effect of the rolling action. Further, the pressure F_2 applied to the pasty product 16 is independent of the speed of movement of the printing head.

Whilst this printing head provides for much improved screen printing, it has been established that in some circumstances this printing head does not provide for sufficient shear thinning of the pasty product 16 as necessary for a perfect print.

In the screen printing process, as illustrated in Figure 3a, incomplete filling of the stencil apertures 19 can result where the pasty product 16 is not sufficiently thinned. Where the stencil apertures 19 are incompletely filled, the action of the trailing wiper blade 11 can shear the pasty product 16 over the stencil apertures 19, with the result that the pasty product 16 in the apertures 19 is pushed to one, the forward, end of the apertures 19, as illustrated in Figure 3b, resulting in only a partial print. In an extreme case, the remaining pasty product 16 in the stencil apertures 19 may not be in sufficient contact with the circuit board 20 such that when the circuit board 20 and the stencil 13 are separated, the pasty product 16 is insufficiently adhered to the circuit board 20 and remains in the stencil 13, as shown in Fig 3c, resulting in virtually no print at all. Furthermore, the retention of pasty product 16 in apertures 19 of the stencil 13 can itself lead to problems with subsequent prints since, as mentioned hereinabove, the pasty product 16 is prone to drying out and the drying out of pasty product 16 in the apertures 19 will give rise to printing problems.

These problems have been made worse by recent trends in miniaturisation which have led

to the use of smaller stencil apertures 19, which minaturization reduces the area of pasty product to circuit board contact relative to the area of pasty product to aperture wall contact.

Accordingly, the present invention provides a screen printing head for applying a pasty product to a printing screen, comprising: a main body; wiper blades disposed to the main body for contacting a printing screen; a first chamber providing a reservoir for containing a supply of pasty product, the first chamber being defined at least in part by the main body and including at least one outlet opening through which pasty product is in use forced under pressure; a second chamber in fluid communication with the at least one outlet opening, the second chamber being defined in part by the main body and the wiper blades and being in use in communication with the printing screen; and a flow director disposed in the second chamber and configured such as in use to cause a circulatory flow of pasty product contained therein which passes over the surface of the printing screen and a flow of pasty product towards the printing screen which acts to force pasty product of the circulatory flow towards the printing screen and into apertures therein.

Such a printing head provides for enhanced shear thinning of the pasty product filled into the apertures of the printing screen and hence improved stencil aperture filling to reduce the incidence of poor quality printing.

Preferably, the at least one outlet opening comprises an elongate slot.

Preferably, the flow director is further configured such as to define first and second circulation zones in which pasty product is locally circulated and through which the circulatory flow is directed.

Preferably, the flow director comprises vanes, with the circulatory flow in use passing beneath lower edges of the vanes.

More preferably, the flow director comprises first and second vanes disposed on opposed sides of the at least one outlet opening, with the lower edges of the vanes defining a nozzle directed towards the printing screen.

Preferably, the nozzle is an elongate nozzle.

Preferably, the main body includes first and second lobe members which in part define the second chamber, the lobe members being disposed above respective ones of the wiper blades and having arcuate lower surfaces to promote the circulatory flow.

In one embodiment the main body includes one or more ports through which the first chamber can be charged with pasty product.

In another embodiment the main body includes a replaceable cassette which defines at least in part the first chamber, the first chamber being charged by replacement of the cassette.

Preferably, the wiper blades comprise flexible wiper blades.

The present invention also extends to a screen printing apparatus comprising the above-described printing head.

The present invention also provides a method of screen printing using a screen printing head including a chamber in communication with the printing screen, comprising the steps of: providing a circulatory flow of pasty product in the chamber which passes over the surface of the printing screen; and providing a flow of pasty product towards the printing screen which acts to force pasty product of the circulatory flow onto the printing screen and into apertures therein.

Preferably, the method further comprises the step of locally circulating pasty product in first and second circulation zones through which the circulatory flow is directed.

The present invention further provides a printing head for screen printing, through which printing head pasty product to be printed can be pressed by applied pressure, comprising a chamber into which pasty product can be charged and in which the same can be placed under pressure, an exit slot from the chamber for pasty product to be printed and a downstream chamber in communication with the exit slot, wherein the downstream chamber is closed at an exit end thereof in use by flexible wiper blades and by a portion of a screen through which the pasty product is to be printed, and the downstream chamber is subdivided by vanes to define pasty product flow paths along which pasty product will flow as a result of movement of the printing head over the stencil in use, the flow paths comprising circulating flow above the wiper blades and flow towards the stencil between the vanes as a result of the circulating flows and movement of the pasty product through the exit slot due to the applied pressure.

The present still further provides a method of screen printing using a printing head, through which printing head pasty product to be printed is pressed by applied pressure, comprising the steps of charging pasty product into a chamber and placing the same under pressure for movement towards an exit slot from the chamber and into a downstream chamber in communication with the exit slot, the downstream chamber being closed at an exit end thereof by flexible wiper blades and by a portion of a screen through which the pasty product is to be printed, subdividing the downstream chamber by vanes to define pasty product flow paths along which pasty product flows as a result of movement of the printing head over the stencil, the flow paths comprising circulating flow above the wiper blades and flow towards the stencil between the vanes as a result of the circulating flows and movement of the pasty product through the exit slot due to the applied pressure.

A preferred embodiment of the present invention will now be described hereinbelow by way of example only with reference to the accompanying drawings, in which:

Figure 1 illustrates a sectional view through a squeegee as employed in a traditional screen printing technique;

Figure 2 illustrates a sectional view through a known screen printing head;

Figures 3a, 3b and 3c show the development of defects which can occur during screen printing using the printing head of Figure 2;

Figure 4 illustrates a perspective view of a screen printing head in accordance with a preferred embodiment of the present invention;

Figure 5 illustrates a sectional view through the printing head of Figure 4; and

Figure 6 illustrates a sectional view through the printing head of Figure 4 when in operation.

The screen printing head comprises a main body 30, in this embodiment an elongate body, and first and second inwardly and downwardly directed wiper blades 31, 32 which are clamped to the main body 30 by respective clamping plates and screws. As illustrated in Figures 5 and 6, the wiper blades 31, 32 are in use maintained in contact with a stencil 34, which includes a plurality of apertures 36 and is located above a workpiece 38, in this embodiment a circuit board, onto which deposits of a pasty product are to be printed. In this embodiment the printing head is symmetrically arranged about the longitudinal axis thereof such as to be moveable bi-directionally.

The main body 30 includes first and second lobe members 42, 44, in this embodiment projections, between which an outlet opening 46, in this embodiment an elongate slot, is defined, and first and second chambers 48, 50 in fluid communication through the outlet opening 46. As will be described further hereinbelow, each of first and second lobe members 42, 44 has an arcuate lower, roof surface 52, 54. One, the first, of the chambers 48 provides a reservoir for containing a pasty product 56 and is defined in part by a flexible diaphragm 58 which is in use acted upon to drive pasty product 56 under pressure into the other, second chamber 50. The other, second chamber 50 provides first and

second circulation zones 60, 62 in and through which pasty product 56 is circulated as will be described further hereinbelow. In this embodiment the main body 30 includes a plurality of ports 63 for charging the first chamber 48 with pasty product 56. In this embodiment the second chamber 50 is in use totally enclosed from the atmosphere to prevent drying out of the pasty product 56, with the stencil 34 in part enclosing the second chamber 50.

The printing head further comprises a flow director 63 disposed in the second chamber 50 adjacent the outlet opening 46. The flow director 63 comprises first and second vanes 64, 66 which each extend a distance parallel to the lower surface 52, 54 of respective ones of the first and second lobe members 42, 44 adjacent the outlet opening 46 such as to define passages 67, 68 therebetween and downwardly to define a nozzle 69, in this embodiment an elongate nozzle, therebetween which is spaced rearwardly from the plane defined by the lower edges of the wiper blades 31, 32 such as to allow for a flow of the pasty product 56 therebeneath. With this configuration, the printing head is effectively divided into four sections as defined by the first chamber 48, the first and second circulation zones 60, 62 and the internal space of the flow director 63.

The printing head further comprises sealing members 70 at each of the ends thereof, which sealing members 70 are formed of a flexible material so as to conform to the wiper blades 31, 32 which deflect during printing.

In use, the printing head is brought into contact with the stencil 34 which is located above the underlying workpiece 38. A force F_2 is applied to the flexible diaphragm 58 so as to pressurize the pasty product 56 in the first chamber 48 and force the same through the outlet opening 46 into the second chamber 50, the pasty product 56 being forced through the passages 67, 68 and the nozzle 69 into contact with the stencil 34. The printing head is then moved, under a horizontal force F_1 , across the stencil 34, which movement in conjunction with the adhesion of the pasty product 56 to the stencil 34, causes a circulatory flow of the pasty product 56 in the circulation zones 60, 62 as depicted by arrows 72. Pasty product 56 from the leading circulation zone, in this embodiment the second

circulation zone 62, is drawn by adhesion to the stencil 34 between the nozzle 69 and the stencil 34, causing shear thinning of the pasty product 56 in this region. This flow of the pasty product 56 increases the pressure within the trailing circulation zone. in this embodiment the first circulation zone 60. and pasty product 56 is forced back to the leading circulation zone 62 through the passages 67, 68, thereby further shear thinning the pasty product 56. At the same time, the action of the pasty product 56 introduced through the outlet opening 46 into the second chamber 50 is such as to apply a pressure through the nozzle 69 directly to the freshly shear-thinned pasty product 56 in the region below the nozzle 69, forcing the shear-thinned pasty product 56 into apertures 36 in the stencil 34.

The printing head of the present invention provides for better shear thinning than any of the known printing heads, particularly in the critical region between the nozzle 69 and the stencil 34, and provides for much improved packing of pasty product 56 into the stencil apertures 36. The wiper blades 31, 32 are thus able to cleanly cut off the pasty product 56 across the top of the stencil apertures 36, without leaving any voids in the stencil apertures 36. In this way, good contact is established between the pasty product 56 and the workpiece 38 over the full area of the stencil apertures 38, thereby ensuring good separation of the pasty product 56 from the stencil 34 on separating the stencil 34 from the workpiece 38, and as a result high quality printing.

Finally, it will be understood that the present invention has been described in its preferred embodiment and can be modified in many different ways without departing from the scope of the invention as defined by the appended claims. For example, alternative designs for the first chamber 48 are clearly possible, such as an interchangeable cassette system, as disclosed, for example, in WO-A-98/16387. Also, the shape and size of the flow director 63, in particular the nozzle 69, and the first and second chambers 48, 50 can be altered from those of the illustrated embodiment. In particular, the widths of the outlet opening 46 and the nozzle 69, the width and length of the passages 67, 68, and the clearance between the lower edge of the nozzle 69 and the stencil 34, all have an effect on the operation of the printing head and can be altered to provide the desired balance between shear thinning and the maximum feed rate of the pasty product 56.

CLAIMS

1. A screen printing head for applying a pasty product to a printing screen, comprising:
a main body;
wiper blades disposed to the main body for contacting a printing screen;
a first chamber providing a reservoir for containing a supply of pasty product, the first chamber being defined at least in part by the main body and including at least one outlet opening through which pasty product is in use forced under pressure;
a second chamber in fluid communication with the at least one outlet opening, the second chamber being defined in part by the main body and the wiper blades and being in use in communication with the printing screen; and
a flow director disposed in the second chamber and configured such as in use to cause a circulatory flow of pasty product contained therein which passes over the surface of the printing screen and a flow of pasty product towards the printing screen which acts to force pasty product of the circulatory flow towards the printing screen and into apertures therein.
2. The printing head of claim 1, wherein the at least one outlet opening comprises an elongate slot.
3. The printing head of claim 1 or 2, wherein the flow director is further configured such as to define first and second circulation zones in which pasty product is locally circulated and through which the circulatory flow is directed.
4. The printing head of any of claims 1 to 3, wherein the flow director comprises vanes, with the circulatory flow in use passing beneath lower edges of the vanes.
5. The printing head of claim 4, comprising first and second vanes disposed on opposed sides of the at least one outlet opening, with the lower edges of the vanes defining a nozzle directed towards the printing screen.

6. The printing head of claim 5, wherein the nozzle is an elongate nozzle.
7. The printing head of any of claims 1 to 6, wherein the main body includes first and second lobe members which in part define the second chamber, the lobe members being disposed above respective ones of the wiper blades and having arcuate lower surfaces so as to promote the circulatory flow.
8. The printing head of any of claims 1 to 7, wherein the main body includes one or more ports through which the first chamber can be charged with pasty product.
9. The printing head of any of claims 1 to 7, wherein the main body includes a replaceable cassette which defines at least in part the first chamber, the first chamber being charged by replacement of the cassette.
10. The printing head of any of claims 1 to 9, wherein the wiper blades comprise flexible wiper blades.
11. A screen printing apparatus comprising the printing head of any of claims 1 to 10.
12. A method of screen printing using a screen printing head including a chamber in communication with the printing screen, comprising the steps of:
providing a circulatory flow of pasty product in the chamber which passes over the surface of the printing screen; and
providing a flow of pasty product towards the printing screen which acts to force pasty product of the circulatory flow onto the printing screen and into apertures therein.
13. The method of claim 12, further comprising the step of locally circulating pasty product in first and second circulation zones through which the circulatory flow is directed.

14. A screen printing head for screen printing, through which printing head pasty product to be printed can be pressed by applied pressure, comprising a chamber into which pasty product can be charged and in which the same can be placed under pressure, an exit slot from the chamber for pasty product to be printed and a downstream chamber in communication with the exit slot, wherein the downstream chamber is closed at an exit end thereof in use by flexible wiper blades and by a portion of a screen through which the pasty product is to be printed, and the downstream chamber is subdivided by vanes to define pasty product flow paths along which pasty product will flow as a result of movement of the printing head over the stencil in use, the flow paths comprising circulating flow above the wiper blades and flow towards the stencil between the vanes as a result of the circulating flows and movement of the pasty product through the exit slot due to the applied pressure.
15. A method of screen printing using a printing head, through which printing head pasty product to be printed is pressed by applied pressure, comprising the steps of charging pasty product into a chamber and placing the same under pressure for movement towards an exit slot from the chamber and into a downstream chamber in communication with the exit slot, the downstream chamber being closed at an exit end thereof by flexible wiper blades and by a portion of a screen through which the pasty product is to be printed, subdividing the downstream chamber by vanes to define pasty product flow paths along which pasty product flows as a result of movement of the printing head over the stencil, the flow paths comprising circulating flow above the wiper blades and flow towards the stencil between the vanes as a result of the circulating flows and movement of the pasty product through the exit slot due to the applied pressure.

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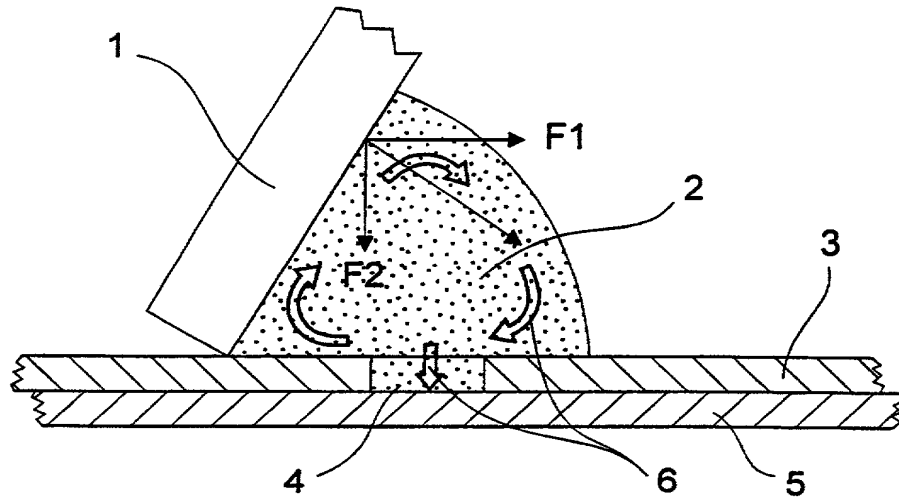


FIG. 1

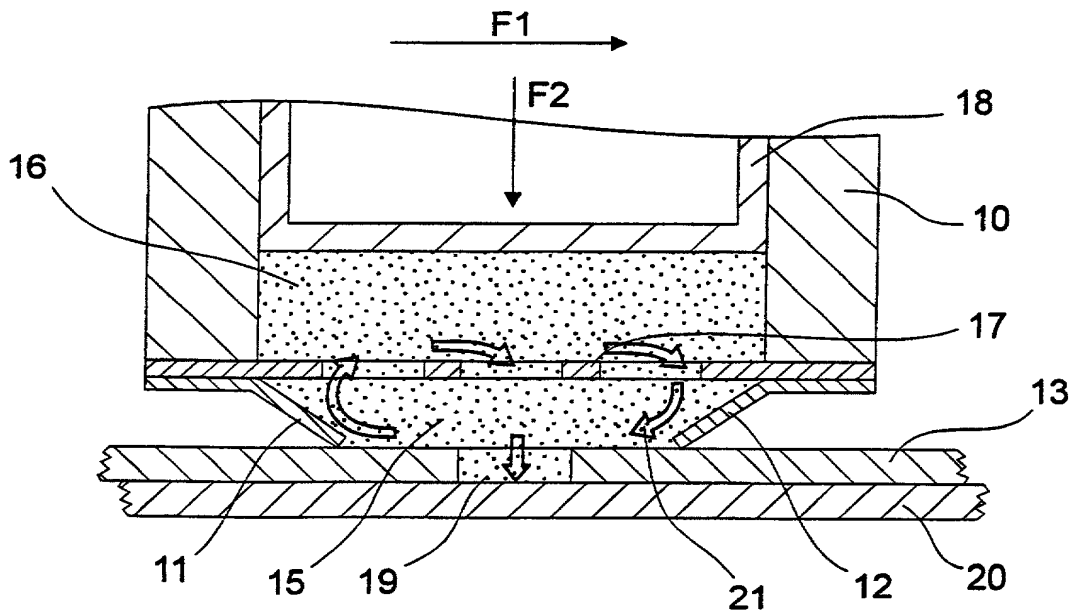


FIG. 2

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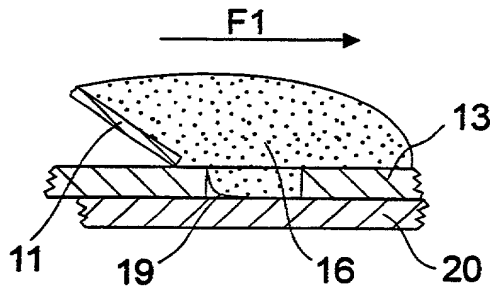


FIG. 3a

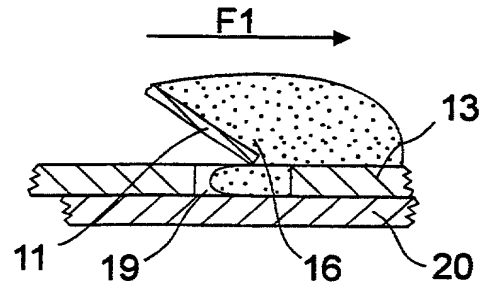


FIG. 3b

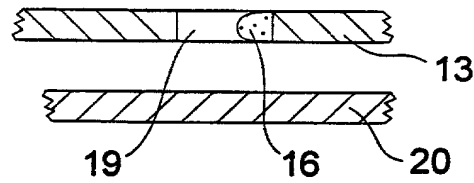


FIG. 3c

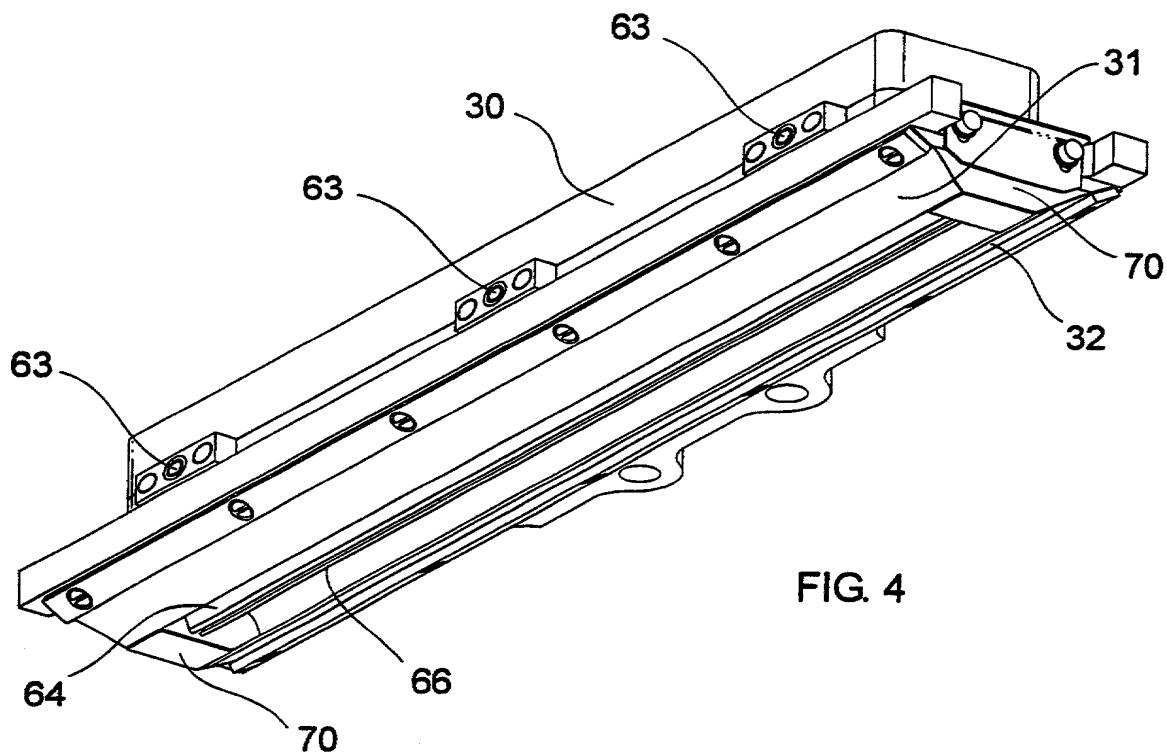


FIG. 4

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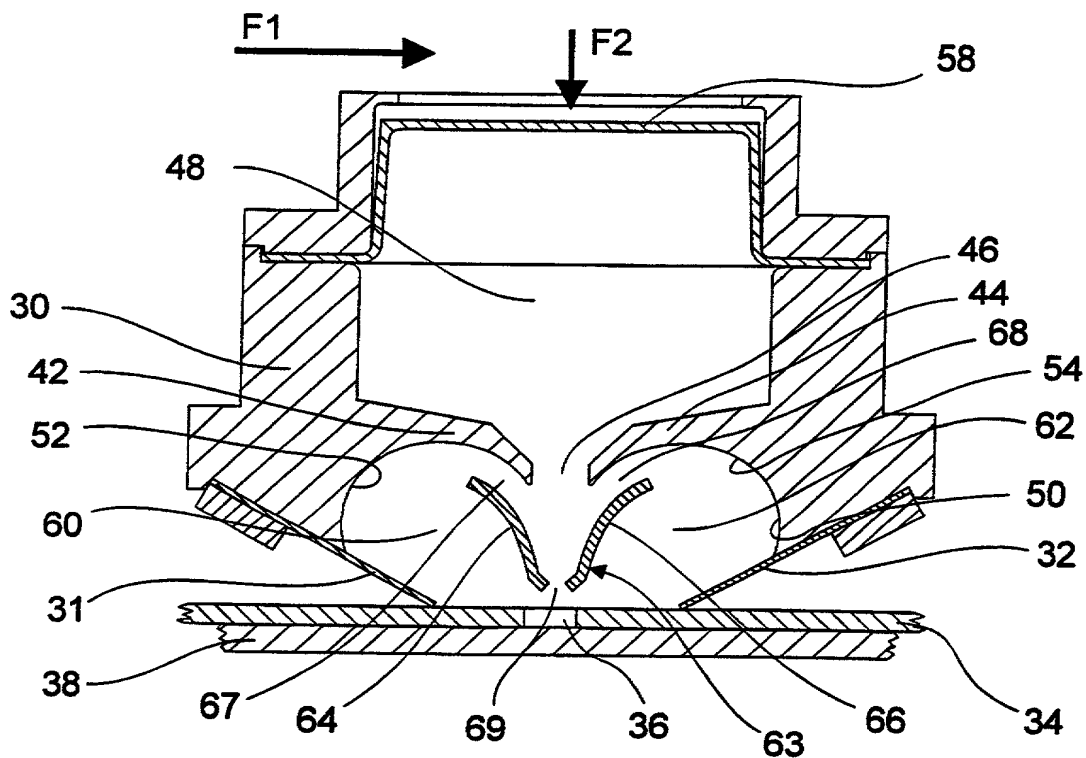


Fig. 5

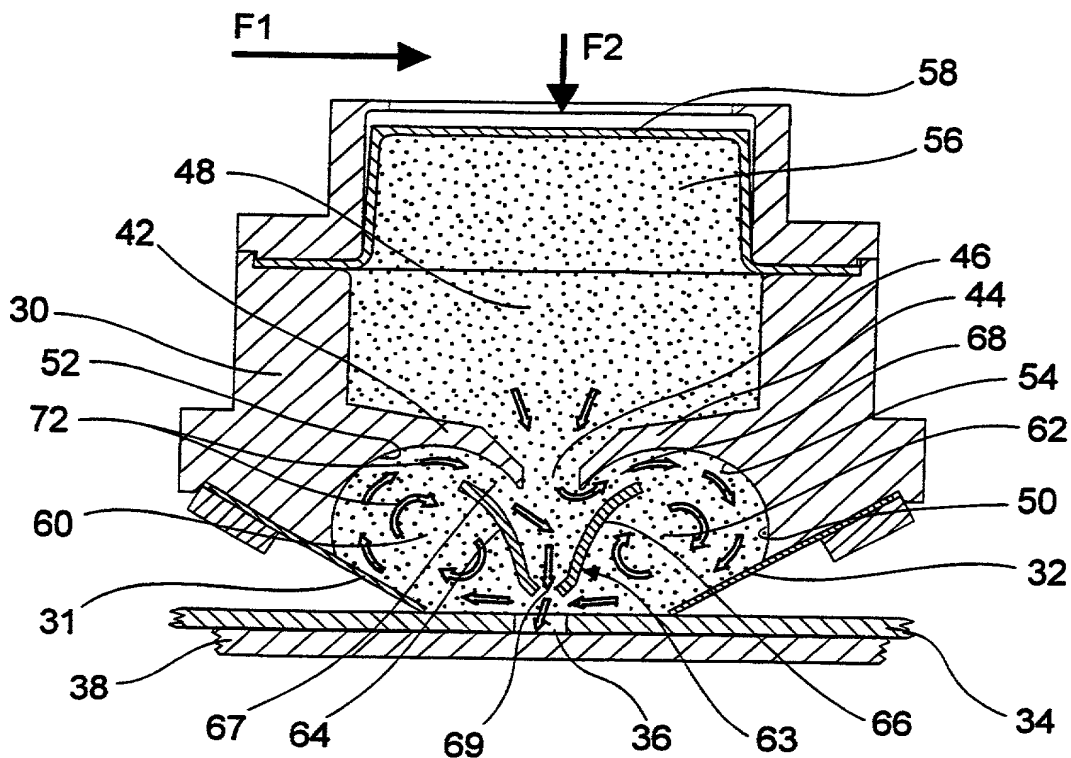


FIG. 6



COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled Improvements Relating to Screen Printing the specification of which:

_____ is attached hereto.
X was filed on January 18, 2002 ✓
as United States Application Number 10/031,336
or PCT International Application Number _____
and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

<u>Prior Foreign Application(s)</u>			<u>Priority Claimed</u>	
<u>9916906.2</u> ✓ (Number)	<u>UK</u> ✓ (Country)	<u>19 July 1999</u> ✓ (Day/Month/Year Filed)	<u>X</u> Yes	_____ No
<u>PCT/GB00/02781</u> ✓ (Number)	<u>WO (PCT)</u> (Country)	<u>19 July 2000</u> ✓ (Day/Month/Year Filed)	<u>X</u> Yes	_____ No

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below

<u>(Application Number)</u>	<u>Filing Date</u>
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I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Application Number) Filing Date (Status – patented, pending, abandoned)

(Application Number) Filing Date (Status – patented, pending, abandoned)

(Application Number) Filing Date (Status – patented, pending, abandoned)

5- I hereby appoint Toni-Junell Herbert, Registration No. 34,348, Mark R. Shanks, Registration No. 33,781, Joseph G. Contrera, Registration No. 44,628, Christina M. Gadiano, Registration No. 37,628, Shelly Guest Cermak, Registration No. 39,571, of SHANKS & HERBERT, telephone (703) 683-3600, with a mailing address at:

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Alexandria, VA 22314

with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

The undersigned hereby authorizes the U.S. attorneys named herein to accept and follow instructions from undersigned's assignee, if any, and/or, if the undersigned is not a resident of the United States, the undersigned's domestic attorney, patent attorney or patent agent, as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorneys and the undersigned. In the event of a change in the person(s) from whom instructions may be taken, the U.S. attorneys named herein will be so notified by the undersigned.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application of any patent issued thereon.

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Inventor's Signature: _____

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